

II. Response to Claim Rejections under 35 USC § 103

Paragraph 3:

Claims 208-213, 215, 217-220, 235, 238, 240-247, are rejected under 35 U.S.C. § 103(a) as being unpatentable over Tanaka (WO 97/11518) in view of Takeuchi et al (US 5,239,188) and Ohba et al (US 5,656,832), and further in view of Harunori et al (JP-07-201745).

Paragraph 5:

Claims 214, 216 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Tanaka in view of Takeuchi et al and Ohba et al, and further in view of Tischler et al (US 5,679,152).

III. The Examiner's Response to Applicants' Arguments

Paragraph 6:

In paragraph 6 of the Action, the Examiner states that the arguments in the Amendment filed on June 9, 2005, were not considered to be persuasive. The Examiner takes the position that the subject matter of claims 208 and 217 are at least suggested by the disclosure of Ohba et al at column 6, lines 10-25, of an off-angle in the range of 0.5 to 10° since 0.5° is less than 1°. In addition, the Examiner states that in view of the combination of the cited references, the step-wise substrate is obvious and would have been expected to contribute to the quality of the crystal grown. The Examiner further takes the position that Harunori et al is not directed to a problem that is different and distinct from that of the present invention. In this regard, the Examiner states that crystal defects (e.g., dislocations or micro-

cracks) are still cracks and small cracks grow into large cracks.

IV. Applicants' Response

Applicants respectfully traverse the rejections and submit that the cited references, whether taken alone or in combination, do not teach or suggest the presently claimed invention as a whole.

Current independent claims 208 and 217 include the steps of (a) forming a mask for selective growth on a dissimilar substrate and forming an underlayer made of a nitride semiconductor on the major surface of the dissimilar substrate step-wise having an off-angle less than 1° with terrace portions and stepped portions, and (b) growing nitride semiconductor portions from opening portions exposed by the selective growth mask. Therefore, the present invention requires ELO (Epitaxially Lateral Overgrowth) and a specific off-angle applied thereto.

Applicants provide the following table summarizing the teachings of the cited references as compared to the present invention.

Table

Reference	Invention	Harunori	Ohba	Takeuchi	Tanaka	Tischler
Substrate	Terrace and Step Portions	Step-wise	Flat	(none)	(none)	(none)
Off-Angle	less than 1°	2-10°	0.5-10° preferably 1-5°	(none)	(none)	(none)
Growth method	ELO	As grown	As grown	ELO	ELO	Not ELO

As can be seen from the above Table, the primary references, Tanaka and Takeuchi et al disclose an ELO growth method, but do not disclose the formation of terrace and step portions or off-angle structures. The step of forming terrace and step portions would require extra time and costs and one of ordinary skill in the art would not have been motivated to modify or combine Tanaka and Takeuchi et al and employ such a time and cost consuming step based on the disclosures of these references.

Further, since neither Takeuchi et al nor Tanaka discloses employing an off-angled substrate, one of ordinary skill in the art would not have been motivated to modify or combine these references with Harunori and Ohba et al, since neither of these references relates to an ELO growth method. Further, as shown in the above Table, from the disclosures of Harunori and Ohba et al, one of ordinary skill in the art would recognize that an off-angle of 2-10° is preferable for a step-wise substrate, whereas 0.5-10° is preferable for a flat or non-step-wise substrate. Thus, one of ordinary skill in the art would not have been motivated to employ an off-angle of less than 1° as recited in the present claims for a step-wise substrate, because this contradicts the teachings of both Harunori and Ohba et al. Namely, if a step-wise substrate was employed, then its off-angle would be 2-10° according to the teachings of Harunori et al, while an off-angle of 0.5-10° or more preferably 1-5° would be employed for a flat substrate, based on the teachings of Ohba et al.

Even further, since Harunori et al and Ohba et al belong to different technology, i.e., deposition on a flat substrate versus deposition on a step-wise substrate, respectively, one of ordinary skill would not have been motivated to combine the references with a reasonable

expectation of success. Consequently, it is improper to interchange the specific conditions from one to the other. Such a modification would render the invention unsuitable for its intended purpose.

Even if Takeuchi et al, Tanaka, Harunori et al and Ohba et al could be combined (a point which Applicants do not concede), the present invention would not be achieved. As discussed above, Harunori et al discloses an off-angle structure with terrace and step portions but the off-angle is taught as being within the range of 2-10°, which is not within the presently claimed range. Such an off-angle of 2-10° is not suitable for the present invention for the reasons set forth above and because the desired surface morphology cannot be obtained as discussed below and as shown in the attached Declaration under 37 C.F.R. § 1.132. Therefore, Harunori et al teaches away from the claimed invention.

Ohba et al discloses forming an off-angle of 0.5-10°, but on a flat substrate and does not relate to ELO at all. Moreover, Ohba et al suggests the range of the off-angle is preferably 1-5°, which is not within the claimed range of less than 1°. In this regard, Applicants submit the attached Declaration under 37 C.F.R. § 1.132, which shows that the surface morphology is unexpectedly superior at an off-angle within the claimed range and inferior at an off-angle outside of the claimed range, i.e., above 1°. (An unexecuted copy, which shows the Samples in color is submitted along with the executed copy).

In view of the above, even if one of ordinary skill in the art could combine Harunori et al and Ohba et al (again, this is a point Applicants do not concede), the present invention employing an off-angle of less than 1° on a step-wise substrate would not have been achieved.

At best, the skilled artisan would have employed an off-angle in the range of 1-5° based on the teachings of an off-angle of 2-10° by Harunori and a preferable range of 1-5° of the broader range of 0.5-10° taught by Ohba. Thus, the unexpectedly superior effects of the claimed invention with respect to surface morphology would not have been achieved.

Further, Applicants submit that the Examiner has failed to appreciate the distinction between the purpose of Harunori et al as directed to the reduction of crystal defects or lattice defects of the as grown GaN epitaxial crystal on the sapphire and that of the present invention of improving the quality of overgrown nitride semiconductor layers as it relates to the issue of whether there is sufficient motivation to combine. Applicants submit that even if one of ordinary skill in the art were motivated to combine Tanaka, Takeuchi et al and Ohba et al as suggested by the Examiner, the claimed invention would not have been achieved because neither Tanaka, Takeuchi et al or Ohba et al teaches or suggests the element of an off-angled major surface being formed step-wise such that the substrate has substantially horizontal terrace portions and stepped portions. For this element the Examiner relies on Harunori et al, which is not directed to the same problem to be solved in the present invention. In other words, Harunori et al focuses on the as-grown GaN epitaxial crystal itself on the sapphire, and not on further growth of nitride semiconductor layers on such GaN epitaxial crystal. To improve the quality of overgrown nitride semiconductor layers, the development of cracks is the key issue. In other words, if an underlayer had cracks inside, then the overlayer would continuously form cracks from the underlayer. However, Harunori cannot reduce cracks formed in the GaN epitaxial crystal itself on the sapphire, because if an overlayer is grown on the GaN epitaxial crystal as taught by Harunori, then such an overlayer would also develop cracks.

Therefore, since Harunori cannot solve the problem which the present invention solves, one of ordinary skill in the art would not have been motivated to combine the references with a reasonable expectation of achieving the claimed invention as recited in amended claims 208 and 217.

In addition, the present invention defines a specific off-angle for an ELO application of less than 1° . Although Ohba teaches an off-angle of $0.5-10^{\circ}$, such an off-angle is simply and solely formed on a flat substrate which does not include terrace portions and step portions and, as previously stated, is not for application in ELO. In addition the broader range of $0.5-10^{\circ}$ would not be preferable, even if applied to ELO as discussed above. Harunori et al teaches an off-angle of $2-10^{\circ}$ as the preferred range in claim 5 and [0019], which teaches away from the present invention, wherein the off-angle is 1° or less as discussed above. Consequently, one of ordinary skill in the art would not have been motivated to combine Tanaka, Takeuchi et al, Ohba et al and Harunori et al with a reasonable expectation of success in achieving the claimed invention.

With respect to the rejection of claims 214 and 216, Applicants submit that Tischler does not remedy the deficiencies of the combination of Tanaka in view of Takeuchi et al and Ohba et al. Specifically, Tischler does not teach or suggest an ELO growth method, a substrate having terrace and step portions and an off-angle, much less within the claimed range of less than 1° .

Applicants also submit that the present invention can reduce a generation of minute cracks by specifying the off-angle for an ELO application. Such unexpectedly superior results could not have been achieved based on the cited references, whether taken alone or in

combination. In this regard, Applicants refer to the previously submitted Experimental Report provided with the Amendment filed on September 16, 2004 and the discussion on pages 15-16 of the Amendment, which is incorporated herein by reference. Based on a comparison between Figures A1 and A2 and B1 and B2 it can be seen that the present invention reduces penetrating dislocation by forming off-angles within the specified claim range and growing a nitride-based semiconductor laterally on the main surface, as well as reducing morphology and internal cracks, resulting in a nitride-based semiconductor with better crystallinity. Thus the present invention provides unexpectedly superior results over the prior art.

In view of the above, the present invention is not rendered obvious by the cited references, whether taken alone or in combination, since one of ordinary skill in the art would not have been motivated to modify or combine the references with a reasonable expectation of achieving the claimed invention having a narrowly defined range for the off-angle. Further, the Declaration under 37 C.F.R. § 1.132 establishes that the present invention provides superior results which would not have been expected by one of ordinary skill in the art. Therefore the claimed invention is patentable.

Accordingly, Applicants respectfully request withdrawal of the obviousness rejections.

V. Request for Interview

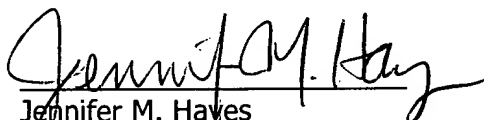
Applicants respectfully request an Interview with the Examiner before the next Office Action on the merits. The undersigned can be reached directly at (202) 775-7533 to schedule an Interview at a convenient time for the Examiner.

VI. Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,


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